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Upstream Attractiveness of the Brazilian oil and Natural Gas Sector: An Assessment based on the Stakeholders' Perceptions

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Abstract- This study provides an overview of 25 Upstream attributes of the Brazilian oil and natural gas sector and of the country itself, identifying from the industry stakeholders' perspective the strengths and weaknesses that were aggregated with the support of SPSS (Statistical Package for the Social Sciences) in four factorials: Trade, Regulatory, Prospectivity and Business Environment. The four field surveys which totalled 1,143 structured face-to-face interviews were conducted during the 2012, 2014, 2016 and 2018 editions of Rio Oil & Gas, the largest trade fair of the industry in Latin America. The methodology used - based on established international research, competitive determinants related to industry and market structures, and traditional variables to assess the attractiveness of the segment - seems to have been consistent with the intended objective to elucidate issues to statistically confirm current opinions and to bring original information. The conclusions indicate that the Brazilian Upstream, in the perception of the industry stakeholders, exerts considerable influence on the attraction of investments, although it presents an unstable performance. The segment is attractive in attributes of natural endowments, such as geological potentiality, and issues related to knowledge and innovation, such as university infrastructure and R&D requirements. On the other hand, poor results from trade issues, certain regulatory variables and the business environment highlight structural and bureaucratic hurdles that undermine Brazil's ability to attract more investments. In an overall balance of all variables, the attractiveness conditions declined between 2012 and 2016 and have rebounded recently.

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I. Introduction

The exacerbation of the competitive scenario for investments in the exploration and production of oil and natural gas has increased in the last five years, despite the instability of the price of the barrel. Between 2016 and 2018, one hundred auctions were held in 82 countries, totalling 3,000 blocks and allowing national and provincial governments to raise about US$ 9 billion in Signature Bonus[13] (ODDONE, 2018). The entry of dozens of countries in the global struggle for the attraction of resources of the sector results, above all, from technological advances that have widened exploratory frontiers. Companies contend for the most lucrative opportunities; nations strive to know which one will be the host of these investments.

In this competition, attractiveness matters. The more attractive a country is to investment, the more leeway it would have to expand, in theory, its share in the business, either via government take[24] (government participation, such as royalties, and special participation), an indicator regularly used by the oil industry to compare tax regimes or through benefits (such as a more aggressive local content policy). That is, the greater the perceived attractiveness, the more likely it is to capture higher incomes, certain that a high value will inhibit investments, while a level below the "optimal value" will mean revenue losses for the country holding the oil resources.

There are different profiles in this dispute: traditional producers with vast reserves and different characteristics - some with political stability and legal certainty[35], such as the U.S.A. and Canada; others

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[13] The Signature Bonus is a traditional selection criterion in bidding for concession agreements. The value of the bonus is associated with the companies' expectations regarding the productive potential of the disputed blocks and the degree of competition for the area in the bidding round (IBP, 2018).

[24] The IHS-CERA Report to the U.S. Department of the Interior (DOI) evaluated 29 tax systems related to oil and natural gas from 20 countries. Brazil occupies an intermediate position in the ranking, 19th among the 41 systems investigated. The modeled terms for the study are following the regulatory framework of concession before the approval of Law 12.351/2010. The sharing model had not been released at the time the report was written, "[...] however, the minimum 30% of state participation was modeled under the concession system to determine the likely increase in government participation." By applying such a measure in the existing concession system, there is a 12% increase in government take, from 59% to 71% in the case of high-yield oil fields (AGALLIU, 2011).

[35] They are evaluated from the perspective of risk analysis companies, such as the Economist Intelligence Unit, Eurasia, The Global Economy, Moody's, Standard and Poor's and Fitch.

whose potential offsets the relative instability[46], such as Russia, Egypt, and Mozambique. Also, those holding huge reserves however marked by political instability, such as Venezuela, Libya, Iraq, Indonesia, and Nigeria. Venezuela, for instance, has reserves of 303 billion barrels (BP, 2018) - 1st in the global ranking - but its attractiveness from the companies' perspective, depends on the reestablishment of political stability.

The competitiveness of countries with medium reserves and with some instability, such as Yemen, Ecuador, Bolivia, and Gabon, depends on stimulating trade conditions, as the institutional deficit charges a price from those that cannot compensate it with geological potentiality. In turn, low potential nations, with small reserves - certain provinces in the U.S.A. and Canada, France, Papua New Guinea, and England - seek to compensate for their disadvantages by offering benefits.

On the other hand, the technological revolution that allowed the development of shale gas and tight oil[57] in the U.S.A., Argentina, and China took a step forward with cost reduction, calling into doubt the expensive oil era and adding a new competitor to the traditional competition for investment. In this context, it is important to stress that barrel at moderate prices means oil companies with less capital, which makes them more selective and increases global competition for these resources. Also, the world is experiencing a transition to a carbon-free economy and the pressure to reduce fossil fuel consumption increases every day, according to the objectives of the Paris Agreement. The electric car is progressing, and several countries announce that they intend to cease the sale of gasoline and diesel vehicles. Clean energy sources, such as solar and wind, gain ground quickly with increasingly competitive costs, prompting oil companies to diversify their business to renewable projects. That is, oil is likely to lose ground and become obsolete in the long term (ANP, 2018).

In this conjuncture of rising international competition, uncertainty about the price level of the barrel and doubts about the longevity of the use of fossil resources as the leading supplier of primary energy, Brazil offers unique conditions for attracting investments due to its geological potential, especially offshore, where the Pre-salt layer stands out significantly[68]. However, this attribute alone in this scenario may not be enough to support a model of exploration of natural resources that can broadly internalize the benefits of this wealth.

Thus, from the host country perspective, which aims not only to attract investments[79] but to take over a larger share of the oil income, it is pressing to properly manage the attractiveness requirements and an agenda of efforts to improve it. If improvements in attractiveness can increase the possibilities of gains for the country, it seems strategic to systematically measure the variables that influence the investment decision, allowing governments to identify and quantify strengths and weaknesses of the country and monitor the performance of public policies.

The perception of Brazilian Upstream attractiveness[810] depends on the interviewee's position. Employees of oil companies usually have a different view from that of suppliers, who in turn do not think exactly as consultants and service providers or students. This study captured the perception of a wide and varied range of stakeholders[911] and we believe that this diversity of opinions can help to avoid biases arising from the concentration of opinions on a particular part of the industry.

The scope of the study is limited to the perspective of attracting investments and their expansion and does not take into account the different theoretical approaches on which the problem could be studied. Like the work of Duque Dutra (2017), we do not seek to analyse the extent to which the attraction of foreign investment to Upstream contributes, or not, to the process of enriching a country, or what the policy of exploring natural resources would be more appropriate for this wealth to effectively contribute to the development of a nation. Also, we seek not to judge the performance and socioeconomic cost of the current models in the country. Our study focuses on the economic perspective of oil and gas sector stakeholders, with emphasis on Brazilian and foreign oil companies regarding the country's performance in 25 attributes associated with attractiveness.

II. Methodology Employed in Field Research

The construction of attractiveness attributes received contributions from three sources:

[46] For Spiller and Holburn (2000), an unstable government would offer little or no credibility assurance against direct or indirect expropriation of private property, which would discourage private investment.

[57] Unconventional natural gas and oil, imprisoned in rocks of low permeability called shale, require a special technique for its production known as hydraulic fracturing. For more information, see FGV Energia (2019), IEA (2014) and Kahrilas et al. (2014).

[68] The definition used here for "Pre-Salt" refers to the section geologically limited by the occurrence of carbonate rocks, in the Santos and Campos basins, underneath salt layers of the Aptian age (Papaterra, 2010). Pre-Salt, whose pioneering discovery was made by Petrobras, is characterized by large accumulations of light oil, with very high productivity, excellent quality and high trade value. According to Oddone (2018), it is one of the best opportunities in the world in terms of oil and gas.

[79] Given the limitations of a study measuring stakeholder perception, this study defines "investment" simply as an expectation of those interviewed, without speculating or making projections based on the responses.

[810] A term used in the oil industry that encompasses exploration, drilling and production activities.

[911] A term used here in its broader meaning, comprising all those who have an interest in the Upstream of the oil and natural gas sector.

i. The Global Petroleum Survey, from the Fraser Institute (FRASER, 2012, 2016, 2018), provided the baseline questionnaire with variables used in surveys that measure perceptions of oil and gas producing countries.

ii. The book "Made in Brazil - Desafios Competitivos para a Indústria" (FERRAZ *et al.*, 1996) contributed to the understanding of the determinants of competitiveness that transcend the company level and are related to the structure of industry and market, and the productive system as a whole.

iii. The dissertation "Atratividade do *Upstream* da Indústria de Petróleo Brasileira - 1997-2003" (Araújo, 2004) reinforced the importance of traditional variables that influence the attractiveness of countries: Political Risk, Regulatory Risk, Government Take and Geological Potential[1012].

a) Technical Characteristics of the Research

Descriptive quantitative research, using the flow point[1113] method, with non-probabilistic sampling, with a sample survey in its scope.

i. *The study population*

The study population was estimated at 4,400 Rio Oil & Gas Congress participants, the largest fair in the sector in Latin America, based in Rio de Janeiro. The composition of the sample is representative of the Brazilian Upstream, formed by the main stakeholders of the sector, presenting a wide variety of positions, functions, and backgrounds-in particular, entrepreneurs, executives, geologists, engineers, economists, administrators, teachers, journalists, financiers, investors, environmentalists, and lawyers. The number of respondents varied in each edition: 166 (2012), 288 (2014), 339 (2016) and 350 (2018), totalling 1,143 people.

ii. *The Questionnaire*

It was structured with 25 close-ended questions related to attributes of the country and the oil and gas sector and with 12 questions in order to collect data from the interviewee. For the evaluation of the factors according to the levels of attractiveness or non-attractiveness towards investment, a scale of 1 (high degree of discouragement to investment) to 5 (high degree of encouragement) was used, 3 being a neutral position. The questionnaire was submitted to a cognitive pre-test answered by 25 experts from the industry; after this procedure, it was reviewed and tested on three interviewees; and then translated and diagrammed.

III. Research Results

The 25 variables are briefly contextualized here, and the results are presented as figures showing the evolution of the historical series, in the form of average, which shows the central tendency of the answers. With the support of SPSS data analysis software, factorials which aggregated the issues in large thematic groups were created: Trade, Regulatory, Prospectivity, and Business Environment.

a) Trade Issues

They involve six variables, shown in Table 1 below. Two of them, concession and sharing contracts, are favourable; four do not contribute to Upstream attractiveness, with emphasis on the tax burden, with pronounced discouragement towards investment. Trade issues, however, tend towards improvement in 2018.

[1012] By using criteria such as a variety of political systems, regulatory and legal regimes and geological profiles, Araújo (2004) selected and analyzed the specific cases of the following countries: The United Kingdom, the U.S.A., Brazil, Norway, Nigeria, Angola, Egypt, and the Congo. For each nation, he applied a score of 1 to 5. Brazil ranked third in the overall ranking, behind the U.K. and the U.S.A.

[1113] Because it is research that uses the flow point method, neither Margin of Error nor Confidence Interval apply.

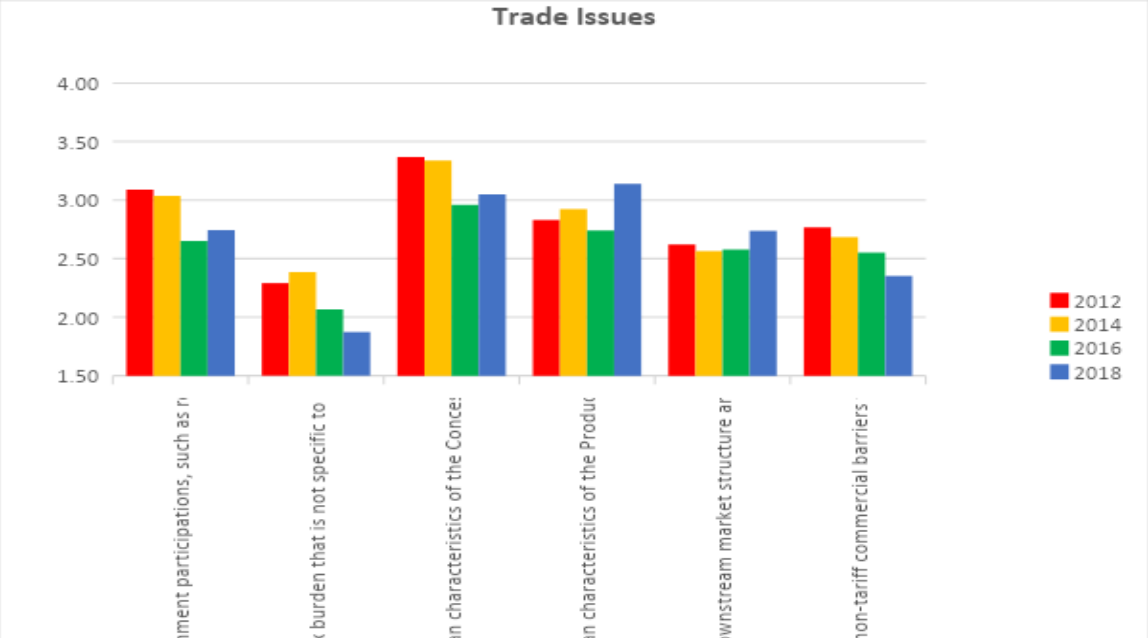
Table 1: Definition of Trade Issues

Group	Issue	Definition
Trade Issues	Government participations, such as royalties, special participations, area retention rates.	Opposite the tax regime, which covers all companies, government participations focus only on Exploration & Production activities of oil and gas. It is an indicator usually used to compare tax regimes.
	The tax burden that is not specific to oil production, including personnel, business, payroll, and taxes on capital and income; the complexity of complying with tax obligations.	Tax burden can be seen as the sum of all taxes - taxes, fees, and contributions - of the three levels of government (Federal, State, and Municipal) - incurred on the economy.
	Brazilian characteristics of the Concession Contract regime.	The concessionaire company has exclusive rights over the area granted during the contract period, recovering costs and making profits through production, with which it pays its due obligations and taxes to the State.
	Brazilian characteristics of the Production Sharing Contract regime.	Sharing contracts: i) operating costs belong to the company or consortium; ii) The result is divided into cost oil, used to recover the incurred costs and profit oil, destined for the profit of the government and the companies[1214].
	The *Downstream* market structure and its pricing policy.	It measures whether the *Downstream* and its market structure operate in competition, if they allow new entrants and if they secure adequate remuneration (systematic of free prices, with the transfer of oscillations to the domestic market).
	Tariff/non-tariff commercial barriers to trade and restrictions on the repatriation of profits.	Law, regulation, policy, measure or practice that restricts foreign trade/for quantitative restrictions, import licensing, customs procedures, antidumping, safeguards and sanitary and phytosanitary measures.

Source: Authors´, 2019.

[1214] Cost oil reimburses the costs of the operation and amortization of the incurred investments; profit oil is distributed among the governments and participating companies, according to the rules determined in the contract, which may be a fixed or variable percentage (Gomes and Alves, 2007).

As shown in Figure 1 below, the variable Government Participations, identified in 2012 as neutral, with an average of 3.1, presented a decline and constituted a slight tendency of discouragement towards investment. This fact could be related to collectibles proposals presented by the Legislative Assembly and the Government of the State of Rio de Janeiro. The state faces a context of fiscal contingencies (FIRJAN, 2017) and finds in the most crucial sector of the state a collectibles explanation[1315], which would bring unpredictability from the perspective of companies (CARNEIRO and DELGADO, 2017).



Source: Authors´, 2019

Figure 1: Evolution of trade issues over the time series 2012 to 2018

There is a growing perception that the *Tax Burden* discourages investments. The issue emerges as the most rejected, with an average of 1.8 in 2018. The hypothesis is that this disapproval is explained mostly by the complexity and cost to comply with the rules, then by the tax burden itself, today at 32.4% (RFB, 2018), a position that tends to the intermediary. For comparison purposes, Mexico has a tax burden of 16.6% of GDP; Denmark, of 45.9% (OECD, 2018). Although with less consensus, tariff/non-tariff trade barriers and restrictions on repatriation of profits also undermine the attractiveness of E&P. They show declining behaviour and, in 2018, their average drops to 2.3.

The *Concession Contract* is only neutral and does not represent an attribute capable of encouraging investments, nor is it an obstacle for the interviewees. One can only infer the reasons for this perception: a collectional tendency from bonus, a vital risk component that the concessionaire pays even before starting the exploratory activity and the increase for the amount paid for the retention of area (IBP-UFRJ, 2016). The *Production Sharing Contract* which, at the beginning of the series, did not comparatively present the performance of the concession regime, improved its evaluation and outperformed its "competitor" in 2018, the concession regime, despite additional costs of governance and risks arising from the need of approval of expenditures incurred by projects. This result shows the flexibility of the companies in dealing with different regimes, but it can also mean a judgment of the Pre-salt geological potential, as the sharing only covers this geological section. In fact, the existence of a better contract cannot be affirmed. As Radon (2005) shows, each presents advantages and disadvantages from several points of view, especially in its trade aspects.

Petrobras owns 98% of the country's refining (ANP, 2018) and considering the opinion of experts like Câmara (2012) and Almeida (2012), its fuel trade policy for specific periods did not follow the basic concept of free prices - monthly evaluations and transfer of international oscillations to the internal market. For those interviewed, this *Structure of the Downstream Market* discourages investments towards Upstream. However, there is a slight improvement, possibly due to carrying out the policy for derivative readjustment by the company in July 2017, which was challenged by a

[1315] The 1.877/12 Bill, which creates the Oil and Gas Inspection Fee (TFPG). The 1.046/15 Bill, with the same objective. The 1.029/11 Bill, which creates the collection of ICMS tax on the consumption of natural gas used in oil production.

truckers' strike in May 2018, demanding a reduction in the price of diesel[1416].

b) Regulatory Issues

Compared to trade issues, the regulatory ones presented and defined in Table 2 below, are slightly better, with three variables considered positive and three seen as negative ones. Despite the significant deterioration in perception between 2014 and 2016, the variables recovered in 2018, except for the compatibility of regulations among the levels of the federation.

Table 2: Definition of Regulatory Issues

Group	Issue	Definition
Regulatory Issues	Predictability in administration, interpretation, and enforcement of regulations that affect the sector, and concern about the frequency of changes.	Clarity of interpretation and stability of business rules and whether changes are made with discretion, arbitrariness, and biased judgement, or unnecessary frequency.
	Complexity and cost of compliance with the laws. If interaction among those who make laws and companies are allowed and encouraged, e.g., through public hearings.	Costs incurred in complying with regulatory determinations, including time, training of personnel and resources for related activities, filing of declarations, attendance to inspections, among others.
	Local Content Requirements.	Operators of exploratory blocks and basins under production must comply with certain percentages of local purchases and assure the preference to the contracting of Brazilian suppliers when their offers have price, term and quality equivalent to those of other suppliers.
	Research and Development Requirements.	Concessionaires must invest in R&D 1% of the gross revenue generated by the basins of high profitability or a large volume of production, being 50% of this amount in their facilities and the remaining 50% in universities or R&D centres.
	Performance of the regulatory agent.	It measures the perception of the ANP, whose assignment is to regulate, contract, and supervise the activities of the oil, natural gas, and biofuel sectors.
	Compatibility of regulations between federal, state and municipal levels.	It checks the functioning and harmony of the administrative competencies of the federative entities - Union, States, and Municipalities -, which exercise them without a hierarchy of one entity over the other.
	Predictability of changes in environmental regulations, environmental licensing, and areas to be protected (parks, indigenous reserves, environmental reserves, marine life, archaeological sites).	It evaluates the functioning of the licensing process of activities of the oil and natural gas sector and the predictability of its regulations.

Source: Authors´, 2019.

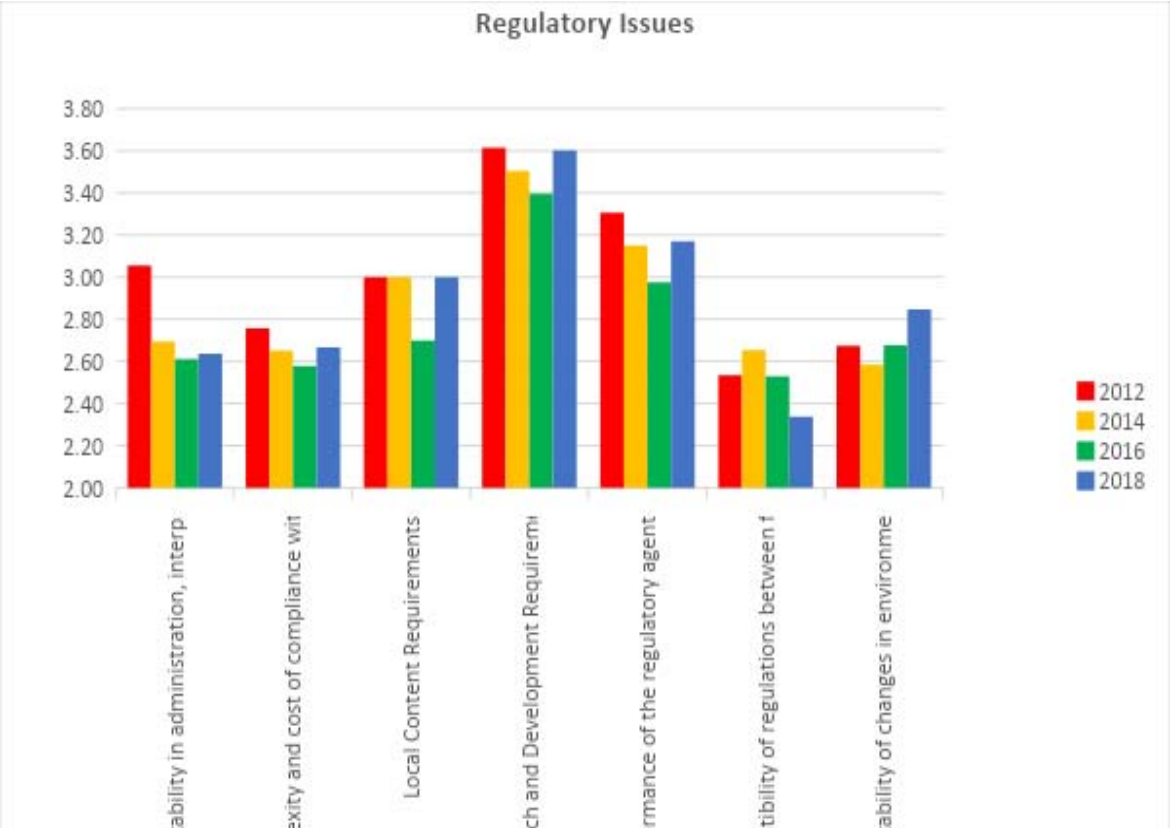
The following Figure 2 shows that the level reached by the variable *Predictability in administration, interpretation, and enforcement of regulations, and frequency of changes* emphasizes the existence of some instability of the regulations of the sector[1517] in the opinion of the interviewees. The result of the issue that measures the *Complexity and cost of compliance with the laws and if there is interaction among those who make them and the companies* indicates that it would be complex and costly to comply with rules in Brazil, as other studies indicate[1618]. It also places the discussion about the possibility of improving the effectiveness of the consultations and public hearings carried out by the National Petroleum, Natural Gas and Biofuels Agency (ANP), the sector's regulatory body, whose process is

[1416] For more on fuel pricing policies and their different impacts on society, including the truckers' strike, see Almeida and Soares (2018).

[1517] The remedy proposed by Levy and Spiller (2009) to avoid these veers is the creation of three mechanisms that complement each other in the improvement of a regulatory framework: i) considerable limitations with respect to the agency's discretion; ii) formal and informal limitations regarding possible changes in the regulatory system and iii) institutions that guarantee these limitations. According to the authors, this framework should be complemented by a set of specific rules capable of providing safeguards against opportunistic behavior coming from regulators.

[1618] Doing Business 2019 (WORLD BANK, 2019), for example, points out that Brazil is one of the countries in the world where it takes more time to deal with the tax bureaucracy. The payment of the tax itself is only one of the stages of a bureaucratic process, preceded by calculations of the value of the tax, forms, and analysis of norms, assessment of possible discounts or tax credits.

transparent and democratic but sometimes discretionary when justifying whether or not to obey the proposals[1719]. The variable shows clear discouragement.



Source: Own elaboration, 2019.

Figure 2: Regulatory Issues

The perception of *Local Content* reaches a level of neutrality, with an average of 3 points throughout the series. Going beyond the surface, we found a certain tendency in the answers: interviewees linked to the operators are more likely to judge the requirement an obstacle towards investment; in principle providers would be inclined to consider it encouraging. The underlying issue is that local content seems to arouse heated debate because it has the power to mobilize nationalistic sentiment. One cannot imagine the repetition of models of extraction of natural resources without the counterpart of the development of a local industry for supplying goods and services.

Operators seem to agree with this premise; however, the period that precedes the creation of a competitive supplier park is marked by conflict. Oil companies want a gradual increase in nationalization percentages, in order to ensure that prices, deadlines, and quality have little impact on their activities; suppliers and governments are pressing for a faster pace, seeking to secure the benefits as quickly as possible. On the other hand, in a scenario of fiscal fragility, governments are more likely to accept lower local content commitments in exchange for higher signature bonuses[18] in the short term, as was the case in Brazil between 2015 and 2017 (Cintra, 2017). On the other hand, the R&D requirements, with an expressive average score throughout the historical series, stand out positively in the interviewees' perception. Despite this result, there is a union of actors in defence of the enhancement of the PD&I Clause (acronym in Brazilian Portuguese for Research, Development and Innovation Clause) of the ANP. They propose that the resources can be used for the development of the supply chain in the country and that the industrial property of the assets

[1719] An interesting approach on the subject can be found in Giserman (2015), which investigates who participates and who influences regulation in processes involving public consultations. According to the author, the characteristics of the regulated sectors help to shape their relationship with the regulator: large companies and concentrated sectors tend towards higher participation.

[18] The Signature Bonus is a traditional selection criterion in the biddings. The bonus value is associated with the expectations of companies regarding the productive potential of the disputed blocks and the competitiveness level for the area in the bid round.

generated by the projects follows federal legislation and not specific restrictive rules created by the ANP (IBP, 2017; ABESPETRO, 2018). Authors such as Florentino (2016) warn the ANP to stay tuned "so that its action changes the relative costs of technological activities for the benefit of society and does not impose costs that prevent positive returns to all agents".

The perception of the role of the ANP, which was deteriorating - average score of 3.3 (2012), 3.2 (2014), and 2.9 (2016) - is recovering and reverses the trend in 2018. For those interviewed, *the role of the regulator body* is not clearly encouraging towards investment nor does it represent an obstacle. The variable that measures the *Compatibility of regulations among the federal, state and municipal levels* shows pronounced disharmony in the Brazilian federalism and impairs the attractiveness of Upstream, with an average of 2.3 in 2018. Concerning the *Predictability of changes in the regulations of the environmental area related to environmental licensing*, there is discouragement towards investment. From the oil companies' perspective, this negative view results from the licensing process, as they believe it could be faster and more predictable. The Brazilian Institute of Oil, Gas, and Biofuels (IBP, the acronym in Brazilian Portuguese), an entity representative of the oil companies, defends the environmental assessment of the blocks offered before the bidding. In the opinion of the entity, the environmental assessment of the sedimentary area and the previous mapping of the socioeconomic impacts of the area to be tendered would contribute to making the licensing process agile, predictable and transparent (IBP, 2017). It is a controversial subject, difficult to be compared with other countries, and differently conceived. According to Verocai (2004), environmental licensing as practiced in Brazil is practically unique worldwide, which prevents a confrontation of deadlines[1921].

c) Prospectivity Issues

In the interviewees' assessment, the *Prospectivity issues* (described in Table 3) are encouraging towards investment, except for Petrobras' stake of 30% and its role as an operator in all blocks of the Pre-Salt.

Table 3: Definition of Prospectivity Issues

Group	Issue	Definition
Prospectivity Issues	Availability of geological data, its quality and detail, and ease of access to public data.	It measures whether BDEP[2022] provides with integrity, safety, and efficiency the data generated by the E&P activities, such as wells (stratigraphic, exploratory and of production) and seismic surveys (2D and 3D).
	The geological potential of the onshore sedimentary basins.	Brazil has 29 sedimentary basins of petroleum interest, with an area of 6,436,200 km², being 76% in land and 24% in the sea (ANP, 2012). Of these, 13 exclusively terrestrial basins and nine which extend from the land to the sea.
	The geological potential of the offshore sedimentary basins.	It measures perceptions about the geological potential of the offshore sedimentary basins.
	Petrobras' stake of 30% and its role as an operator in all blocks of the Pre-Salt.	Law 12.351/2010 changed the regulatory framework of the sector and assigned to Petrobras the obligation of being the operator of all blocks of the sharing regime, with a minimum participation of 30%. A new change made participation optional.

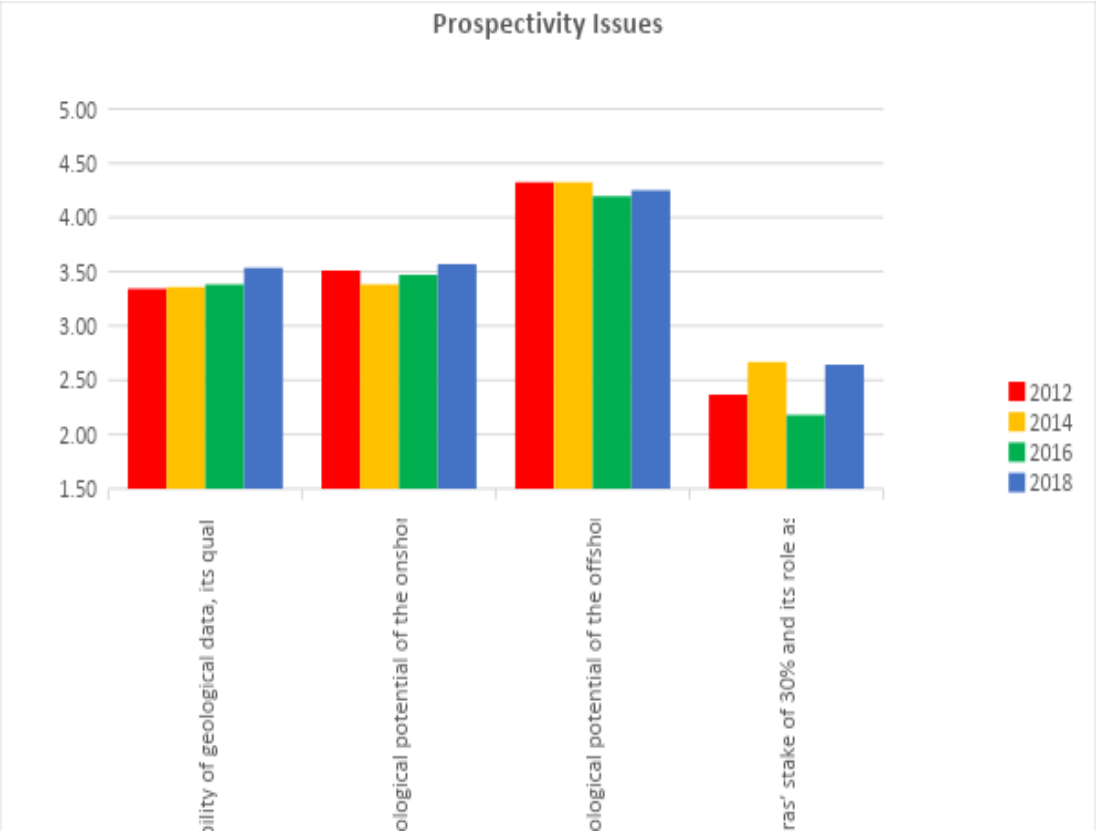
Source: Authors´, 2019

Figure 3 (below) presents the performance of the Prospectivity Issues. *The availability of geological data, its quality and detail, and the ease of access to public data* represent an encouraging factor towards investment in the Brazilian E&P. The issue presents a high and growing average throughout the series. In turn, the *potential of the onshore basins*, with an average of 3.5 in the four editions, is a positive factor. *The geological potential of the offshore basins* is considered highly attractive and stands out among the 25 factors as the most encouraging one towards investment, with a remarkable average of 4.3 points in the four surveys. Even after becoming optional, the controversial Petrobras' stake of 30% and its role as an operator in all

[1921] For the premise of strategic environmental licensing and its use around the world, see MMA (2002).

[2022] Exploration and Production Database from ANP.

blocks of the Pre-Salt is not seen as encouraging towards investment[2123] and is among the five most poorly evaluated, with an average of 2.6 in 2018. An explanation for this perception would be the interpretation that the rule broke the conditions of isonomy that prevailed in the auctions of exploratory blocks.



Source: Authors´, 2019

Figure 3: Prospectivity Issues

d) Issues related to the Business Environment

The issues that assess the Business Environment are presented and defined in Table 4. Although they declined between 2014 and 2016, they show vigorous recovery, except for political stability.

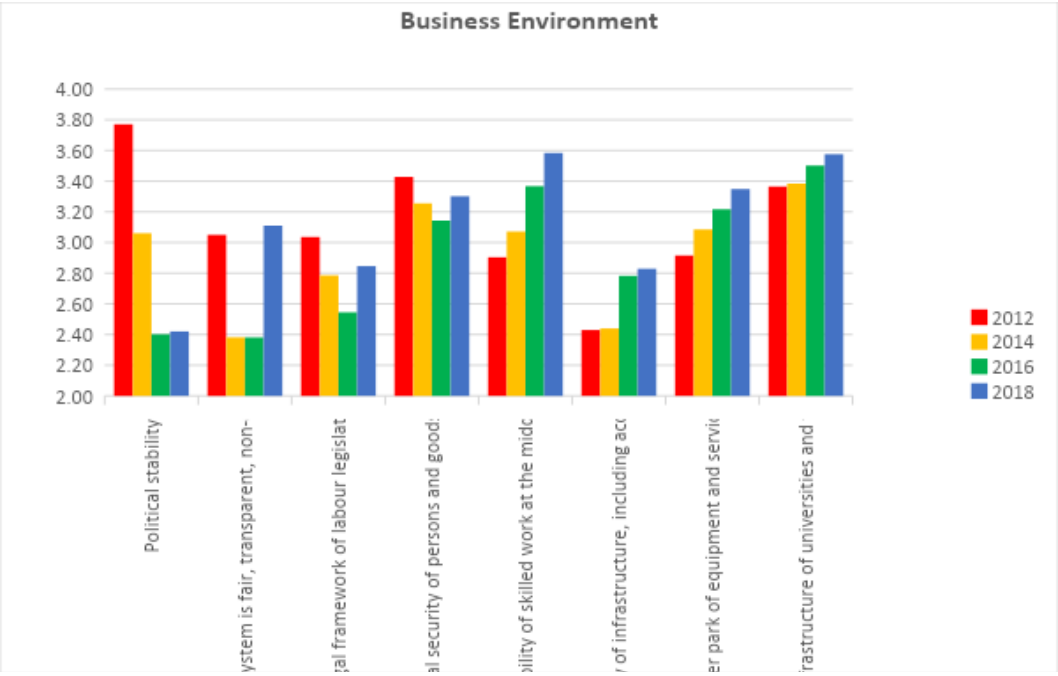
[2123] Although the legislative amendment of 2016 transformed this participation, optional for the winning consortia, the issue was retained as the proposal was still being processed during the execution of this research. Since it is still a relevant issue, we retained it in adapted form in 2018.

Table 4: Definition of Issues related to Business Environment

Group	Issue	Definition
Business environment	Political stability.	It measures the level of risk of inconvertibility and transfer of currency, expropriation, breach of contract, political interference, supply chain disruption, legal and regulatory risk, and political violence.
	Legal system is fair, transparent, non-corrupt and efficient.	It assesses, from the respondents' perspective, whether the legal system functions appropriately, and whether it is capable of limiting administrative discretionary and avoiding eventual improper political interferences.
	The legal framework of labour legislation.	Set of legal norms, principles, and other legal sources governing labour relations, regulating the legal status of workers.
	Physical security of persons and goods.	It measures to what degree the fundamental rights of citizenship, such as the right to life, property, and personal security, are guaranteed in the country.
	Availability of skilled work at the middle, senior and managerial levels.	It evaluates the supply and quality of skilled work at the middle, senior and managerial levels.
	Quality of infrastructure, including access to roads, pipelines, energy availability, etc.	Availability and quality of infrastructure, including roads, railways, pipelines, ports, and supply of electricity and telecommunications.
	Provider park of equipment and services.	The supply chain covers the set of companies that produce goods and/or provide services, directly or indirectly, for Upstream activities in the sector: exploration, development of production, and production.
	The infrastructure of universities and technological and research centres.	It measures the infrastructure supply of universities and R&D centres and the interrelation of organizations to generate innovation.

Source: Authors´, 2019

The following Figure 4 shows the results of the business environment issues throughout the research series. As one would expect from a country that has experienced an impeachment process, the issue of *Political Stability* has dropped sharply, from a highly favourable perspective towards investment, averaging 3.8 points in 2012, to an average of 2.4 in 2016, and repeating the negative performance in 2018. Among the characteristics evaluated by business executives at the time of investing, government stability is a determining factor, although, as North (1996) points out, the very decision-making process of economic and political agents is permeated by subjectivity and uncertainty.



Source: Authors´, 2019

Figure 4: Issues related to Business Environment

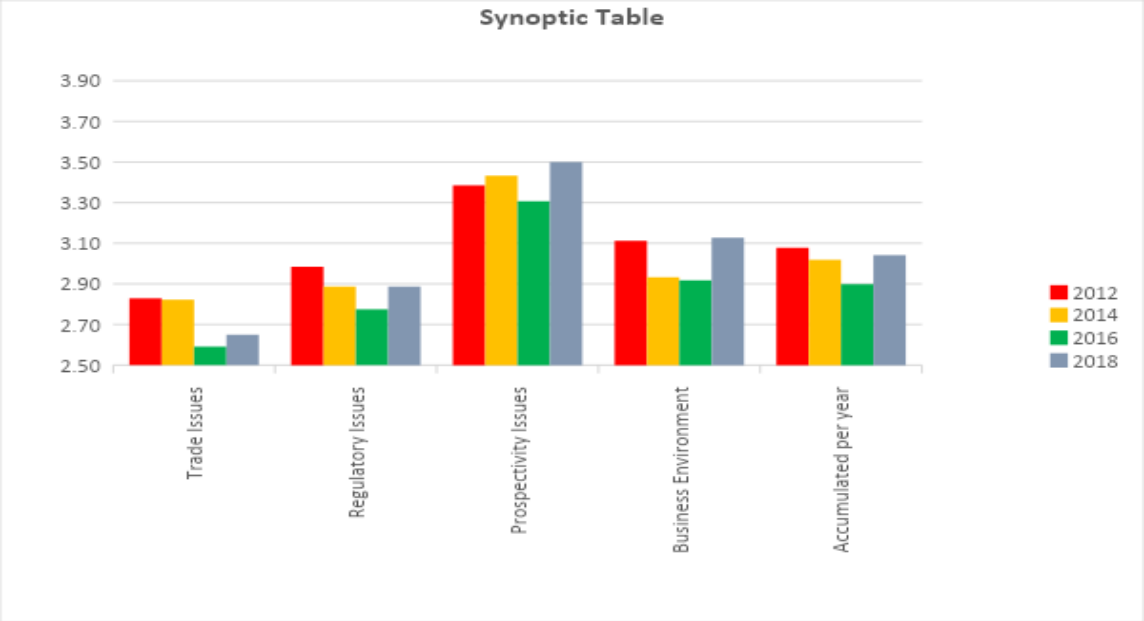
The issue that assesses whether the *Brazilian legal system is fair, transparent, non-corrupt and efficient*, which reached a negative level in 2014 and 2016, achieved a significant recovery in 2018 and returned to neutrality. The reason for this change does not appear easy to discover and one can only speculate that it is related to the controversial protagonist role of the Judiciary at the heart of the political debate of the country. Contrary to current opinion about the *physical security of persons and goods*, the issue improves and reaches a moderately encouraging average in 2018, with 3.3 points.

In the 2012 edition of the survey, Brazil was experiencing accelerated economic growth, with repercussions on the *Availability of skilled labour at the middle, senior and managerial levels*. That year, the variable came close to discouraging investments, with an average of 2.9. The scenario changed and given the idleness of personnel as a result of the economic crisis, the issue became encouraging, with a considerable average of 3.6 in 2018.

The legal framework of labour and labour legislation is another variable whose behaviour has fluctuated. Following a moderately sloped plan, it recovers to an average of 2.8 in 2018, one year after the Labour Reform, which relaxed specific points of the legislation and was considered progress from the companies' perspective. *Quality of infrastructure*, including access to roads, pipelines and energy in particular – which were among the most negative variables – improves and reaches an average of 2.9 in 2018. The provider of equipment and services boasts a gradual and consistent improvement in its perception and encourages investments. In the four editions of the research, the infrastructure of universities and technological and research centres is considered attractive for investment.

IV. Summary of Results

A panoramic view of the 25 variables measured in Figure 5 shows that the attractiveness conditions of the Brazilian Upstream deteriorated throughout the historical series and recovered in the last two years. The country, which averaged 3.1 points on the sum of the issues in 2012, saw its position fall to 3 in 2014, drop to 2.9 in 2016 and finally reach 3.05 in 2018.



Source: Authors´, 2019

Figure 5: General conditions of attractiveness of the Brazilian Upstream

The trade issues concentrating the variables were considered unfavourable for the attraction of investments for the Brazilian Upstream in the opinion the interviewees. The contracts are the two positive exceptions among the six issues associated with the trade issue. The country's tax burden and the complexity of its compliance emerge as the most rejected.

The regulatory issues perform slightly better. The negative highlight is the *Compatibility of regulations among the levels of the federation*, which points to a certain lack of coordination among government instances. The variable that measures the complexity and cost of legal compliance is also highlighted as a dissuasive factor. The general conditions have improved but are still far from encouraging investments.

In the interviewees' opinion, the issues regarding prospectivity are encouraging towards investment, except for *Petrobras' stake of 30% and its role as an operator in the Pre-Salt blocks*. Significant average scores are achieved by the *geological potential of the offshore basins*, highly stimulating to induce investment in the Brazilian E&P. With less exuberance but with a high level of favourable evaluation, the *potentiality of the onshore basins* appears with an average score of 3.5 over the four editions. The issue of availability of geological data and its ease of access is seen as increasingly encouraging towards investment, reaching 3.5 in 2018.

The interpretation of the grouping of the eight variables representative of the business environment established for companies operating in the Brazilian Upstream clearly shows advancements of various issues, except for political stability. Despite this, the levels reached are not high, authorizing the interpretation that transforming the business environment of the sector into a more stable and/or predictable one would be relevant for the consistency of its attractiveness.

V. Analysis via Logit Model

The average score of the 25 attractiveness factors presented a certain dynamic with alternation of placements over time. The extreme positions, the one that most encourages and the one that most discourages investment, however, have remained practically constant. Although each edition of the research presents singular results, the data seem to indicate the presence of a pattern. The potential of the offshore sedimentary basins has emerged as the most stimulating factor to invest in the Brazilian Upstream (see Table 5 below). The R&D requirements (among the three variables best positioned in three editions) and the infrastructure of universities and technology centres (twice among the three-best positioned) also stand out. Other issues present a strong but unstable performance over time.

Table 5: Factors that most influence investments in the oil and natural gas sector in Brazil

	2012	2014	2016	2018
Factors that most encourage investment	Potential of the offshore sedimentary basins	Potential of the offshore sedimentary basins	Potential of the offshore sedimentary basins	Potential of the offshore sedimentary basins
	Political stability	R&D requirements	Infrastructure of universities and technology centres	R&D requirements
	R&D requirements	Infrastructure of universities and technology centres	Potential of the *onshore* sedimentary basins	Availability of skilled labour
Factors that least encourage investment	Tax burden and complexity of its compliance	Legal system is fair, transparent, non-corrupt and efficient	Tax burden and complexity of its compliance	Tax burden and complexity of its compliance

Source: Authors´, 2019.

On the other hand, the tax burden, and the complexity of complying with tax obligations appear as the variable that most discourages investments in Upstream. It is only in 2014 that this variable loses, by a narrow margin, this uncomfortable position, when it is outpaced by the issue of whether the *Legal system is fair, transparent, non-corrupt and efficient*.

The average is the most used measure of central tendency and an important reference to represent a set of data because it more uniformly blends the lower and higher values and thus produces fewer errors. Despite these average attributes, the repeating pattern of results in leadership positions encouraged the refinement of the data to obtain possibly more robust conclusions.

Thus, for checking, the criterion of variable measurement was changed. It was established as a prerequisite to be considered the interviewee's answer to the question, present in the questionnaire, whether one would "invest or not in Brazil in the next two years." Thus, the determinant of attractiveness went beyond the average score reached by the variables. For example, if the average reached by a variable is high, but it is the same for both groups, that is, for those who intend and also for those who do not intend to invest, it would not be possible to conclude that it is a determinant for attractiveness. Since the variable is binary, we chose the Logit method, whose models were arranged to understand the relationship between the scores attributed by the respondents to the 25 factors investigated and their answer to the question about "investing in Brazil in the next two years." Two rounds of models were made: (1) Linear regression with Logit with all variables; and (2) 25 linear regressions with each variable individually.

Binary variables were created for each of the 25 factors surveyed. All variables, as well as their responses, were transformed to become binary and thus able to compose the statistical model. Issues that reached grade 4 or 5, that is, which encouraged investment, received a value of 1; the remaining scores were assigned a value of 0. Thus, an indicator variable of encouragement associated with that factor (which is associated with a question from the questionnaire). In this manner, in summary, one would have: *a) Dependent Variable:* One intends to invest in Brazil in the next two years; *b) Independent variable:* Indicator for the factors associated with each question in the questionnaire.

Operationally, these variables were all included in the model in order to verify which demonstrate adherence to their explanatory significance. The model (shown in the following Figure 6) employing a screen copy of the Phyton Software shows the relation of the 25 questions to the dependent variable. The result shows that the only variables that present the signal equal to the theoretical signal and that are significant to 10% are questions 18 (Political Stability) and 21 (Physical security of people and goods).

```
Optimization terminated successfully.
         Current function value: 0.167725
         Iterations 9
        Logit Marginal Effects
=====================================
Dep. Variable:                      5
Method:                          dydx
At:                           overall
```

	dy/dx	std err	z	P>|z|	[0.025	0.975]
p1	0.0282	0.027	1.045	0.296	-0.025	0.081
p2	-0.0173	0.037	-0.473	0.636	-0.089	0.055
p3	-0.0215	0.036	-0.600	0.548	-0.092	0.049
p4	0.0336	0.032	1.064	0.287	-0.028	0.095
p5	0.0111	0.030	0.371	0.711	-0.047	0.070
p6	0.0105	0.026	0.404	0.686	-0.040	0.061
p7	-0.0218	0.026	-0.823	0.410	-0.074	0.030
p8	0.0144	0.028	0.517	0.605	-0.040	0.069
p9	0.0291	0.027	1.072	0.284	-0.024	0.082
p10	0.0142	0.032	0.442	0.659	-0.049	0.077
p11	0.0390	0.031	1.247	0.213	-0.022	0.100
p12	-0.0310	0.030	-1.036	0.300	-0.090	0.028
p13	-0.0154	0.030	-0.512	0.608	-0.074	0.043
p14	0.0401	0.035	1.140	0.254	-0.029	0.109
p15	-0.1106	0.065	-1.692	0.091	-0.239	0.018
p16	-0.0198	0.063	-0.313	0.754	-0.144	0.104
p17	-0.0094	0.028	-0.338	0.735	-0.064	0.045
p18	0.0939	0.042	2.260	0.024	0.012	0.175
p19	-0.0272	0.030	-0.896	0.370	-0.087	0.032
p20	-0.0068	0.031	-0.222	0.825	-0.067	0.053
p21	0.0476	0.027	1.751	0.080	-0.006	0.101
p22	-0.0086	0.034	-0.251	0.802	-0.076	0.059
p23	0.0436	0.030	1.450	0.147	-0.015	0.103
p24	-0.0781	0.040	-1.931	0.054	-0.157	0.001
p25	-0.0184	0.033	-0.562	0.574	-0.083	0.046

Note: Screen copy of Python Software

Figure 6: Full Logit model

Already at the descriptive level, the data presented stressed that there are elements which indicate that specific characteristics are strongly related to the decision to invest in Brazil. To guarantee a sufficient empirical basis, we chose to carry out a Logit Logistic Regression. According to HAIR et al. (2005), the Logit model can predict the presence or absence of a result based on the values of the independent variables. That is, we can measure the interest in the investment from the result of the independent variables checked in the survey. The possible dependent variable in the questionnaire was the intention to invest in Brazil within the next two years. The others were used as independent variables.

In the Logit model, it is essential to be aware of the "p-value", represented by "p>z", positioned in the fourth column. The significant values in the model are those that are below 0.1, an acceptable value of the statistical agreement for the significance of variables. Some questions are significant: geological potential of the onshore sedimentary basins (Question 15); political stability (Question 18); physical security of persons and goods (Question 21) and quality of infrastructure, including access to roads, pipelines, availability of energy, etc. (Question 23).

However, as we aimed to measure the capability of attractiveness towards investments from the research instrument and the statistical model, we looked for variables that indicated a positive theoretical signal to attract investment. That is noticeable from the second column of Figure 6, represented by the "dy/dx". Only two variables, among the significant ones, showed positive values: political stability (question 18) and physical security of people and goods (question 21). That is, the greater the political stability and the physical security of people and goods, the higher the encouragement for investment, which was statistically proven.

After this procedure, we used the two significant questions as independent variables to explain the desire to invest in Brazil, both being the only ones of the model, removing all others. In the Logit model regarding Political Stability, it was possible to identify that the fact of assigning grades 4 or 5 to the importance of this question to attractiveness increases the chance of investing in Brazil in the next two years by 8.7%. The result is still meaningful at the 5% level, a statistical value taken as a reference for significance. In the model of the physical security of people and goods, granting high marks increases the chance of investing in the country in the next two years by 4.6%. Significance reaches the level of 10%, a less rigid value, but also widely accepted as a paradigm of significance.

Therefore, the data allow us to generally infer that the desire to invest in Brazil is affected by the assessments of the Brazilian Upstream. The two

variables presented are significant, with a greater prominence for Political Stability.

VI. Conclusions

The study constitutes a comprehensive view of the attributes of the Brazilian natural gas and oil sector and of the country itself, identifying strengths and weaknesses in four central themes: trade, regulatory, prospectivity and business environment. The methodological tools used seem to have been consistent with the intended purpose, making it possible to elucidate questions, statistically confirm current opinions and obtain original information. The conclusions indicate that the Brazilian Upstream, in the perception of industry stakeholders, exerts considerable influence in attracting investments, despite its unstable performance. It is assumed that the country has lost part of its capacity to motivate investments due to:

i. Changes in its regulatory apparatus were not considered a necessary evolution, but are elements of instability and uncertainty which ended up obstructing the process of exploratory block bidding rounds for five years. That is the case of the law that assigned Petrobras the role of the operator in all blocks of the Pre-salt, with a minimum participation of 30% in the winning consortia. This arrangement altered the symmetry that existed between Petrobras and the other companies and changed the competitive environment of the sector, altering the isonomy that prevailed through the concession auctions since 1999. Although it is a controversial subject, that arouses nationalistic passions, a considerable part of the respondents seem to have considered that the process of change occurred in an untimely manner;
ii. Deterioration of the economic environment and political stability. The country has had one of the biggest crises in its history in the last five years, combining economic and political aspects. The political crisis culminated with the impeachment of a president; the economic crisis was mixed with a major corruption scandal, initially centred on Petrobras, and investigated by a task force of institutions, which resulted in arrests, ousting and arraignments of hundreds of politicians and businesspeople. In 2015, the rise of Vice-President Michel Temer, whose mandate was marked by accusations, did not pacify the political environment; and
iii. Fragility of the outcome of trade issues and certain regulatory variables and the business environment emphasize structural and bureaucratic obstacles that undermine Brazil's capability to attract more investment and remain as tasks of the economic agenda. Despite significant advances in several fields, from the perspective of a relevant percentage of respondents, the Country has not yet solved issues that place it as a not entirely business-friendly environment, although of high potentiality.

On the other hand, the country has highly encouraging natural conditions for investment, such as its geological potential offshore (mainly) and onshore. The availability of resources for R&D, guaranteed by the 1% Clause of the ANP, combined with a sophisticated trajectory of the sector's supplier of goods and services and with the vigorous investment program of the leading operators, especially Petrobras, has the potential to promote vigorous growth of the sector, aiding its international competitiveness. Such a combination can bring significant results for the development of the country. That was the case with the four largest oil service industry hubs- the United States, the United Kingdom, Norway, and France-which began by promoting efforts to explore and develop national hydrocarbons and made those countries more attractive for investment.

As Bret-Rouzaut and Favennec (2011) argue, "the UK oil services industry has been developed internationally in tandem with its success in the domestic market." Norway had a shy start in the 70s, but by cooperating with other countries, learning from their experiences and adopting policies to support the "infant industry," it achieved esteemed technological empowerment by using its market as a springboard for its international expansion (RYGGVIK, 2014 and GUIMARÃES, 2011). In France, an oil-poor country, the state has played a crucial role in the internal growth and development of the para-oil services industry. Brazil, on the other hand, needs to ensure isonomic conditions of competition to Brazilian suppliers, not only for improving the business environment but also for macroeconomic issues such as taxes, interest rates and foreign exchange (CNI, 2019).

The determinants of complex decision-making processes are usually plural and interrelated. The single explanations are not enough. If, however, we attempt synthesis, we must recognize that in the oil industry, the risk-reward binomial is treated differently compared to other sectors of the economy. Thus, although all 25 variables have been carefully chosen and have an intrinsic value to characterize the perception of attractiveness, a hierarchy from the Pre-Test with 25 experts from the sector places two of them in the first positions: offshore and onshore geological potential. The third would be political stability. Logit analysis, thereby, confirms the importance of political stability and identifies the relevance of the physical security of goods and people (the closely related variable to political stability).

No other sector is capable of rewarding risk as oil does. Evidence for this is that even countries with fragile institutions and even those in civil war, such as Iraq and Libya, are able to attract investment if their relevant geological variables (volumes and dynamics of accumulation, for example) are good and whether general market trends (oil price and demand for derivatives in particular) are favourable. Despite receiving investments, these countries pay a high price because companies usually use a discount rate that reflects the degree of risk involved.

Therefore, despite unfavourable assessments in several variables, Brazil meets unique conditions due to its geological potential, especially offshore. If the potential attributed by nature is considerable, however, it is up to the country to improve institutional conditions. The geological predicate must not operate on its own and must be in line with other favourable attributes, since all these conditions can help the country increase the share of government oil income and enable an ambitious natural resource exploration model, capable of internalizing the benefits of this wealth widely. Therefore, an agenda for improving attractiveness is needed, since the resources of oil and natural gas, if properly applied, have the potential to make Brazil a more egalitarian country, prepare it for energy transition and improve its goods and services industry, making it competitive internationally.

Attractiveness matters and can materialize in increasing a nation's oil income and multiple other benefits; however, a warning is warranted. As Stiglitz (2005) states, generally countries rich in natural resources perform worse than those with smaller amounts of resources, but not all have the same fate. Forty years ago, Indonesia and Nigeria had similar per capita incomes, and both relied heavily on oil revenues. Indonesia's per capita income is now four times higher than that of Nigeria, which has even fallen. There is a vast theory about rentier states. The question is also addressed by Evans (2004) in his definition of the Predatory State from the example of the Democratic Republic of Congo (ex-Zaire). That seems to be the reality of some municipalities in the Northern *Fluminense*[2224], where resources from oil royalties while potentially vital have not transformed poor municipalities into prosperous and sustainable economies on their own. An extensive set of studies in Brazil and abroad shows that not only is there no direct correlation between oil wealth and economic development, but in many cases, there appears to be a negative correlation[2325]. By knowing the evils of the so-called Curse of Natural Resources[2426], it is up to Brazil to choose its path.

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[2224] One of the six meso-regions of the state of Rio de Janeiro, formed by nine municipalities that concentrate oil production of the Campos Basin, especially Campos dos Goytacazes and Macaé.

[2325] Details on the subject in Brazil can be found in Aquino (2004), Serra *et al.* (2006), and Pizzol and Ferraz (2010). To know the international reality, see Tsalik and Schiffrin (2005), and Gylfason (2000).

[2426] For more on the so-called Curse of Natural Resources, see KARL (2005).

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